

09/15/00
JCE23 U.S. PTO

09-18-00

A

PATENT APPLICATION TRANSMITTAL LETTER

DOCKET NO. CE04708N
Express Mail Label # EL626111331US

Box: Patent Application

Assistant Commissioner for Patents
Washington, D.C. 20231

Transmitted herewith for filing under 37 CFR §1.53(b) is a Nonprovisional:

New Application **XX**; Continuation _____, Division, _____ or Continuation in Part (CIP) _____
of prior US application S/N _____, filed on _____.

Title: **Time-out Shaping For Wireless TCP Communications**

For: **Levenson, et al.**

Enclosed are the following documents:

- XX** Transmittal Letter to PTO;
XX PrintEFS Inventor Information Sheet;
XX 2 sheet(s) of formal drawings and 12 page(s) of specification and claims;
XX Oath or Declaration Combined with Power of Attorney;
XX Unexecuted (original or copy).
_____ Copy from a prior application (if this is a Continuation/Division).
_____ Signed statement deleting named inventor(s) in prior application if
this is a Continuation/Division (see 37 CFR § 1.63(d) and §1.33(b).
_____ Please abandon the prior application identified above as of the filing date
granted to the present Continuation/Division application.
_____ Enclosed is a certified copy of a _____ (non-US) application S/N _____, having
a filing date of _____, and foreign priority to this non-US application for the present application
is hereby claimed under 35 USC §119.
_____ Assignment Transmittal and Assignment to MOTOROLA, INC.
_____ An Information Disclosure Statement and PTO 1449 with references attached.
_____ Preliminary Amendment.
XX Return postcard.

JCE60 U.S. PTO
09/662859
09/15/00

CLAIMS AS FILED

FOR	NUMBER FILED	NUMBER EXTRA	RATE	FEE
TOTAL CLAIMS	19-20		X \$18.00	
INDEPENDENT CLAIMS	3-3		X \$78.00	
MULTIPLE DEPENDENT CLAIM(S)			\$260.00	
ASSIGNMENT DOCUMENT			\$40.00	\$40.00
BASIC FEE				\$690.00
TOTAL FILING FEE				\$730.00

Please charge my deposit account no. **50-0280** in the amount of **\$730.00**.

The Commissioner is hereby authorized to charge any fees under 37 CFR §1.16
and 1.17 which may be required during the entire pendency of this application, or
credit any overpayment, to deposit account No. **50-0280**.

Date

9/15/00

Bruce Terry
L. Bruce Terry, Reg. No. 38,336
MOTOROLA, INC.
Intellectual Property Department - MS E230
5401 North Beach Street
Fort Worth, Texas 76137
Tel: (817) 245-2911; Fax: (817) 245-2137

INVENTOR INFORMATION

Inventor One Given Name:: SAMUEL M
Family Name:: LEVENSON
Postal Address Line One:: 630 N. DRURY LANE
City:: ARLINGTON HEIGHTS
State or Province:: IL
Country:: USA
Postal or Zip Code:: 60004
Citizenship Country:: USA
Inventor Two Given Name:: YUTAI T
Family Name:: KOH
Postal Address Line One:: 614 ABERDEEN WAY
City:: SOUTHLAKE
State or Province:: TX
Country:: USA
Postal or Zip Code:: 76092
Citizenship Country:: USA
Inventor Three Given Name:: MARK S
Family Name:: HANSEN
Postal Address Line One:: 2280 CAMPBELL CREEK BLVD.
City:: RICHARDSON
State or Province:: TX
Country:: USA
Postal or Zip Code:: 75082
Citizenship Country:: USA

CORRESPONDENCE INFORMATION

Correspondence Customer Number:: 23447
Name Line One:: MOTOROLA, INC.
Name Line Two:: TX72, MAILSTOP E230
Address Line One:: 5401 N. BEACH STREET
City:: FORT WORTH
State or Province:: TX
Country:: USA
Postal or Zip Code:: 76137
Telephone One:: 817-245-2911
Fax One:: 817-245-2137
Electronic Mail One:: FTD050C@email.mot.com

APPLICATION INFORMATION

Title Line One:: TIME-OUT SHAPING FOR WIRELESS TCP COMMUN
Title Line Two:: ICATIONS
Total Drawing Sheets:: 2
Formal Drawings?: Yes
Application Type:: Utility
Docket Number:: CE04708N

Secrecy Order in Parent Appl.?:: No

Source:: PrintEFS Version 1.0.1

TIME OUT THRESHOLD SHAPING FOR WIRELESS TCP COMMUNICATIONS

Background of the Invention

Field of the Invention

5 The present invention relates generally to telecommunications networks, and more particularly to the shaping of round trip time delay network packet transmission characteristics to reduce the number of packet time outs occurring during established sessions.

Description of Related Art

10 In conventional telecommunications or data communications networks, communicating nodes establish end-to-end sessions utilizing protocols such as TCP. When a source node transmits a packet to a destination node, it also sets a timer to open an acknowledgement period, based on a TCP-specific algorithm for packet traffic characteristics, during which the destination node must acknowledge correct receipt of the packet. If the source node does not receive an
15 acknowledgement from the destination node before the timer expires, the timer issues a time out, the packet is determined to be lost, and the source node must retransmit the packet to the destination node.

20 For transmission of TCP packets over a wireless network such as a code division multiple access cdma2000 network, packets exchanged during a TCP session may be transmitted over different physical channels over the wireless link. Packets transmitted over these channels may experience widely varying delays. In the case of a cdma2000 network, the transmission time delay characteristics of the two physical channels available may be an order of magnitude apart (typically
25 tens of milliseconds versus hundreds of milliseconds). Generally, longer packets may be transmitted over the slower channel, while shorter packets, such as

packets containing only acknowledgements, may be transmitted over the faster channel, which is the channel that has a smaller capacity per frame. As the above-mentioned TCP-specific algorithm bases the timer acknowledgement period on packet traffic characteristics, if a string of shorter packets is transmitted over the

5 second channel, the time out value generated by the TCP-specific algorithm will be progressively reduced to the point that the transmission of one longer packet on the first channel will cause a time out and therefore cause the longer packet to be re-transmitted. In addition to re-transmitting the packet, the source node may also erroneously determine that the time out was due to network congestion and

10 therefore may reduce the rate of transmission of outgoing packets, thereby further reducing throughput and causing inefficient utilization of the wireless network.

Brief Description of the Drawings

Additional objects and advantages of the present invention will be more readily apparent from the following detailed description of preferred embodiments thereof when taken together with the accompanying drawings in which:

FIG. 1 is a block diagram of a wireless telecommunications system of the type in which round trip time delay shaping in accordance with the present invention is implemented;

FIG. 2 is a graph of time delays associated with packets transmitted from a source node in a prior art TCP communications system; and

FIG. 3 is a graph of time delays associated with packets transmitted from a source node in a TCP communications system utilizing round trip time delay shaping in accordance with the preferred embodiment of the present invention; and

FIG. 4 is a block diagram of an alternative wireless telecommunications system of the type in which round trip time delay shaping in accordance with the present invention is implemented.

Detailed Description of the Preferred Embodiments

Referring now to the drawings in which like numerals reference like parts, FIG. 1 shows a telecommunications network 10 including a source communications node 12 communicating with a destination communications node 14. According to a preferred embodiment, the source communication node 12 is a wireless device, such as a cellular telephone, and the destination communications node 14 is a wireline device, such as a landline server, or a wireless device such as a cellular phone, radio, or any other device capable of communicating over a wireless network 16 through an established protocol, which, according to a preferred embodiment, is cdma2000.

The source and destination nodes 12, 14 communicate with one another by transmitting packets across the wireless network 16 during an established TCP communications link, or session, represented generally at 18. The wireless network 16, which may be capable of supporting either second or third generation air interfaces, includes conventional infrastructure, such as a base station subsystem 20 including base stations and base station controllers, necessary to facilitate wireless transmission of TCP data packets between nodes such as the source and destination nodes 12, 14. In accordance with cdma2000 protocol, TCP packets within the TCP session 18 established between the source and destination nodes 12, 14 may be transmitted between the nodes and across the wireless network 16 over different physical channels, such as a supplementary channel (SCH) SCH 22 and a dedicated control channel (DCCH) 24. Typically, longer packets are scheduled on the SCH 22 and have an associated delay in the hundreds of milliseconds, while shorter packets are scheduled on the DCCH 24 and have an associated delay in the tens of milliseconds. However, more channels having different associated delay times may also be utilized with protocols other than cdma2000.

According to the present invention, a processor 26 such as the one shown in the base station subsystem 20 is programmed with a known time-specific

algorithm that provides an acknowledgement period of predetermined length for each packet transmitted by the source node 12. If the destination node 14 sends an acknowledgement indicating that it has received a corresponding packet from the source node 12, the source node 12 determines that the destination node correctly received the packet in question. If the destination node 14 does not send the acknowledgement within the allotted acknowledgement period, the source node 12 determines that the packet is lost or that the destination node 14 did not correctly receive the packet and therefore retransmits the packet.

Because the system 10 includes multiple channels such as the SCH and DCCH channels 22, 24, delay characteristics for each of the channels may vary. The processor 26, however, only keeps a running average of the overall system delay characteristics without differentiating between delays on the SCH 22 and delays on the DCCH 24.

As shown in FIG. 2, a prior art processor programmed in a conventional manner maintains a running average 30 of the time delays associated with packets transmitted on both the SCH 22 and the DCCH 24. As shown in FIG. 2, a majority of the packets transmitted during the illustrated time period are shorter packets transmitted on the DCCH 24 having shorter associated round trip delays, which is defined as the time measured from transmission of the packet from the source node 12 to receipt of an acknowledgement at the source node 12 from the destination node 14. The prior art processor then calculates a time out threshold 32 having a value that is set above a running average 30 as calculated by conventional TCP/IP compatible algorithms. The prior art processor then calculates a time out threshold having a value that is set above the running average 30 by an amount determined by conventional currently accepted or deployed algorithms of round-trip time estimation. Consequently, a longer, slower packet transmitted on the SCH 22 and having an associated round trip delay represented graphically at 34 that is significantly above that of the numerous shorter packets transmitted on the DCCH 24, typically by a magnitude of 10x, will be timed out, as its time delay is above the time out threshold 32. The slower

packet will be timed out even though the destination node correctly receives the packet. As a result, network capacity is underutilized.

The shaping of round trip time delay network packet transmission characteristics according to the present invention minimizes the occurrence of such unnecessary time outs by automatically increasing the computed running average 30. Specifically, as shown in FIG. 3, the processor 26 executes the above-mentioned time-specific algorithm to compute a running time delay average 30' and a corresponding time out threshold 32' having a value that is set above the running average 30' by a predetermined amount. The processor 26 is also programmed with an algorithm to automatically insert a longer, slower insert packet as illustrated at 40 among the packets being transmitted by the source node 12. Preferably, this slow packet insert algorithm is generated from existing TCP timer adaptation algorithms programmed into the processor, and is tailored so as not to significantly impact system end-to-end performance.

The slow packet insert algorithm causes one insert packet, such as the packet 40, to be inserted on the SCH channel 22 for every X packets that are transmitted by the source node, with X being determined based specific system parameters. The longer insert packet consequently increases the running average 30', and therefore the time out threshold 32', computed by the time-specific algorithm above the running average 30 and time out threshold 32 shown in FIG. 2 that otherwise would have been computed if the longer insert packet 40 was not inserted.

It should be noted that, because the above-discussed TCP sessions are connection-oriented and must be set up when communication is established between the communications nodes 12, 14 and then torn down when the communication is completed, the running average 30', and therefore the time out threshold 32', computed by the time-specific algorithm must be computed on a session-by-session basis in the preferred embodiment.

While the processor 26, in which the round trip packet delay shaper of the present invention has been discussed as being implemented in the base station subsystem 20, the processor 26 may alternatively be implemented in the source communications node 12 as shown in the system 50 in FIG. 4 or, alternatively, in the destination communications node 14.

In addition, it should be appreciated that the shaping of round trip time delay network packet transmission characteristics according to the present invention may be performed for numerous sets of communications nodes that have established TCP communications sessions through the wireless network, as exemplified by the additional communications nodes 112, 114 communicating with one another or with the nodes 12, 14 by transmitting packets across channels 22, 24, 122, 124 or 222, 224 over the wireless network 16 during established TCP sessions represented generally at 18, 118, 218.

In view of the foregoing discussion, it should now be appreciated that the present invention enables maximum utilization of second and third generation CDMA wireless networks by minimizing the number of packets that must be re-transmitted due to unnecessary time-outs. Consequently, the present invention enhances TCP communications on wireless links to achieve greater service transparency as system users move among wireless and wireline environments. Such connectivity will be required by communications nodes in third generation networks that will eventually replace the traditional voice dominated second-generation networks.

While the above description is of the preferred embodiment of the present invention, it should be appreciated that the invention may be modified, altered, or varied without deviating from the scope and fair meaning of the following claims.

Claims

What is claimed is:

1. A telecommunications system, comprising:

a wireless network;

first and second communications nodes for establishing a TCP communications session over the wireless network and for communicating with one another during the TCP communications session by transmitting and receiving data packets across first and second network channels;

the wireless network further including a delay determination node for determining delay characteristics of each of the first and second channels and for causing an insert packet to be transmitted on a slower of the first and second channels at predetermined intervals to increase an average time delay associated with both the first and second channels and to thereby minimize a number of packet time outs on the first and second channels.

2. The telecommunications system of claim 1, wherein the delay determination node comprises a network base station subsystem.

3. The telecommunications system of claim 1, wherein the first node comprises a wireless communications device and the second node comprises one of a wireless and a wireline communications device, and wherein the delay determination node comprises at least one of the first and second subscriber communications units.

4. The telecommunications system of claim 1, wherein the delay determination node is further for being set up on a session-by-session basis.

5 5. The telecommunications system of claim 1, further comprising multiple sets of first and second communications nodes and multiple sets of first and second network channels for establishing respective communications sessions and for communicating with one another during the respective communications sessions by transmitting and receiving data packets across the multiple sets of first and second network channels.

10 6. The telecommunications system of claim 1, wherein the delay determination node is further for generating a running packet delay average and a corresponding time out threshold during the communications session, the delay determination node thereby inserting the insert packet into the running average to increase the running average and the delay determination threshold based on the delay characteristics of each of the first and second channels.

5 7. The telecommunications system of claim 1, wherein the wireless network comprises a cdma2000 network.

20 8. A method for shaping a time out threshold of a wireless telecommunications network, comprising:

identifying a TCP communications session during which first and second communications nodes communicate with one another by transmitting and receiving data packets across first and second network channels;

25 determining delay characteristics of each of the first and second network channels of the TCP communications session; and

30 causing an insert packet to be transmitted on a slower of the first and second network channels at predetermined intervals to increase an average time delay and therefore a time out threshold associated with both the first and second network channels and to thereby minimize packet time outs on the first and second network channels.

9. The method of claim 8, wherein the determining of delay characteristics and the causing of a delay packet to be transmitted are performed by a network base station subsystem.

5 10. The method of claim 8, wherein the determining of delay characteristics and the causing of a delay packet to be transmitted are performed by one of the first and second communications nodes.

10 11. The method of claim 8, further comprising performing the determining of delay characteristics and the causing of a delay packet to be transmitted on a session-by-session basis.

12. The method of claim 8, further comprising simultaneously performing the determining of delay characteristics and the causing of a delay packet to be transmitted for multiple sets of first and second communications nodes.

13. The method of claim 8, further comprising:
generating the average time delay during the identified TCP communications session; and

20 transmitting the insert packet to increase the average time delay and therefore the time out threshold based on the delay characteristics of the first and second channels.

25 14. The method of claim 8, wherein the identifying of a TCP communications session comprises identifying a TCP communications session in a cdma2000 network.

30 15. A processor for shaping a packet time out threshold for a telecommunications network by identifying a TCP communications session during which first and second communications nodes communicate with one another by transmitting and receiving data packets across first and second network channels,

by determining delay characteristics of each of the first and second network channels of the communications session, and by causing an insert packet to be transmitted on a slower of the first and second network channels at predetermined intervals to increase an average time delay associated with both the first and second network channels and to thereby minimize a number of packet time outs on the first and second network channels.

16. The processor of claim 15, wherein the processor is located in a network base station subsystem.

17. The processor of claim 15, wherein the processor is located in one of the first and second communications nodes.

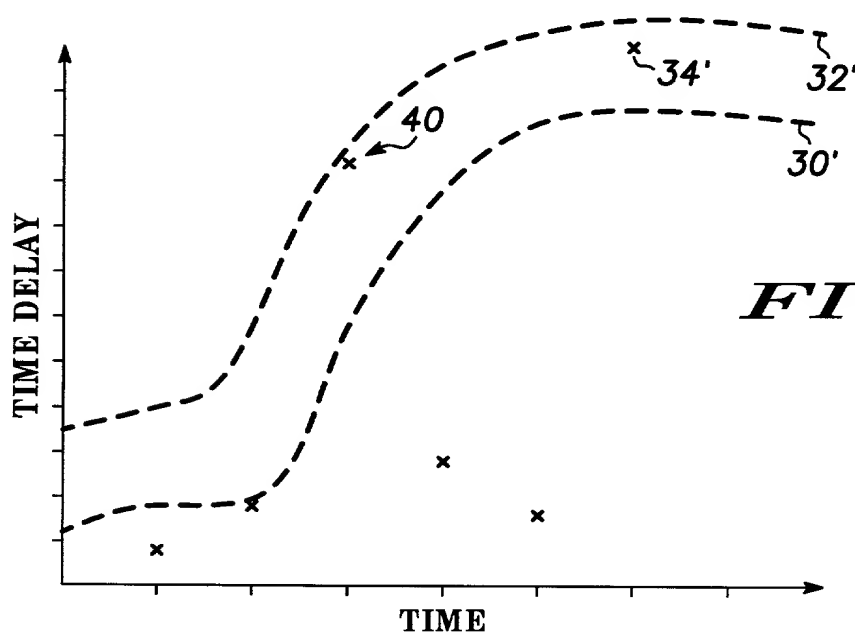
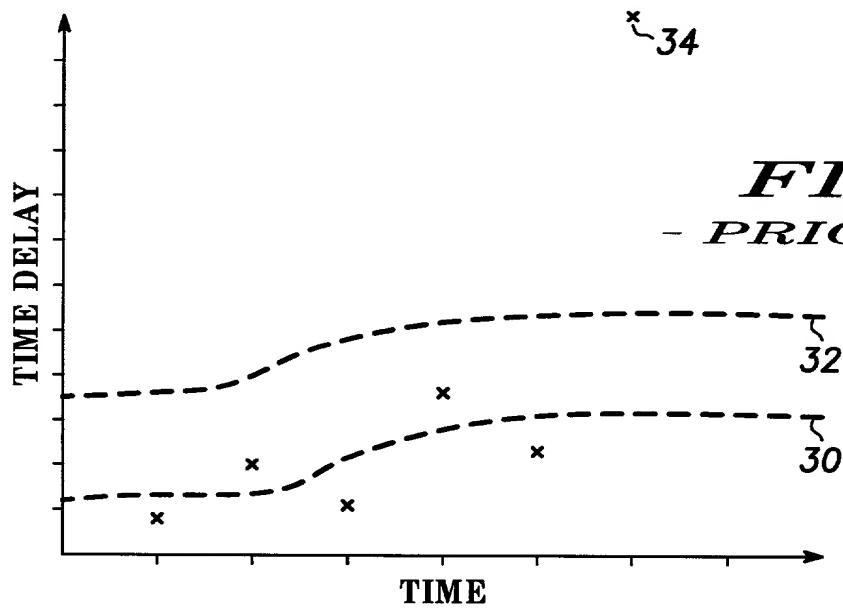
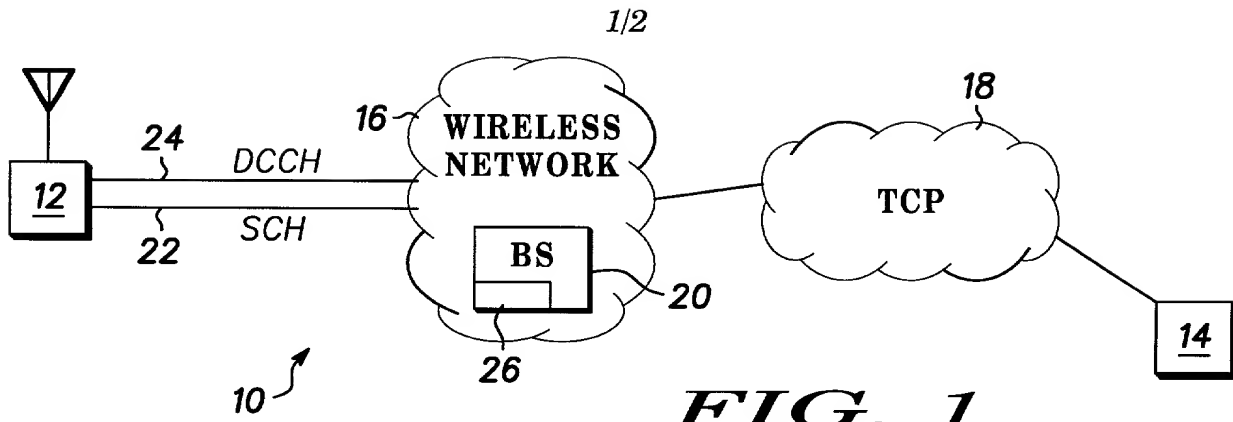
18. The processor of claim 15, wherein the processor is for use in a cdma2000 network.

19. The processor of claim 15, wherein the processor is further for computing a time out threshold based on the average time delay.

TIME OUT THRESHOLD SHAPING FOR WIRELESS TCP COMMUNICATIONS

Abstract

The present invention is for shaping a packet time out threshold in a wireless telecommunications network including a TCP session. First, a TCP communications session (18) is identified during which first and second communications nodes (12, 14) communicate with one another by transmitting and receiving data packets across first and second channels (22, 24) of a wireless network (16). Next, a processor (26) located either in one of the communications nodes (12, 14) or in a network base station subsystem (20) determines delay characteristics of each of first and second channels (22, 24) of the communications session. Once the delay characteristics are determined, the processor (20) causes a delay packet to be transmitted on a slower of the first and second channels (22, 24) at predetermined intervals to increase an average time delay associated with both the first and second channels (22, 24). Consequently, the number of unnecessary packet time outs on the first and second channels (22, 24) is minimized.



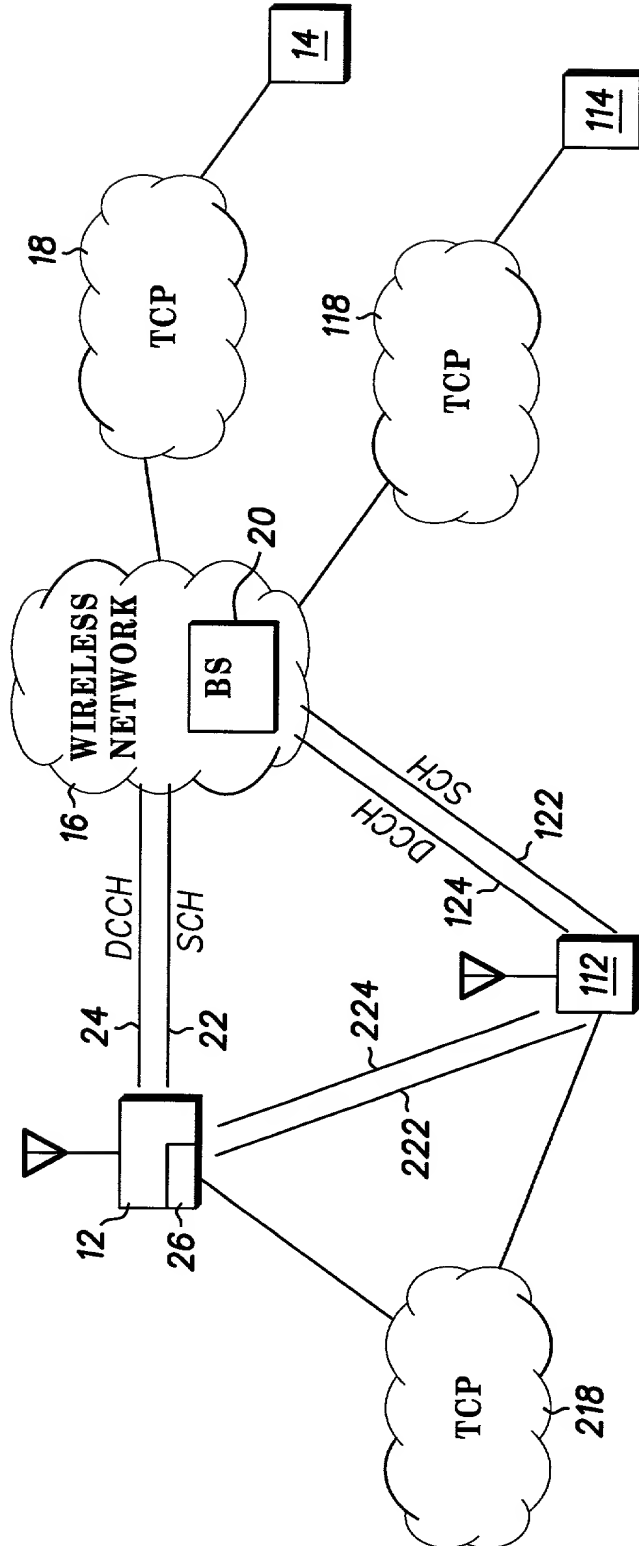


FIG. 4

50

**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION**

Attorney Docket **CE04708N**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **Time-out Shaping for Wireless TCP Communications**, the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as Application No. _____
and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)		Priority Claimed
_____	_____	<input type="checkbox"/> Yes <input type="checkbox"/> No
(Number)	(Country)	(Day/Month/Year Filed)
_____	_____	<input type="checkbox"/> Yes <input type="checkbox"/> No
(Number)	(Country)	(Day/Month/Year Filed)

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

_____	_____
(Application Number)	(Filing Date)
_____	_____
(Application Number)	(Filing Date)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §12, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Number) (Filing Date) (Status - patented, pending, abandoned)

(Application Number) (Filing Date) (Status - patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

L. Bruce Terry
Motorola, Inc.
5401 N. Beach Street, Mail Stop E230
Fort Worth, Texas 76133
Direct Telephone Calls to: (817) 245-2911

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF FIRST INVENTOR Samuel M. Levenson	INVENTOR'S SIGNATURE	DATE
RESIDENCE 630 N. Drury Lane, Arlington Heights, Illinois 60004, USA	CITIZENSHIP USA	
POST OFFICE ADDRESS same as above		

FULL NAME OF FIRST INVENTOR Yutai T. Koh	INVENTOR'S SIGNATURE	DATE
RESIDENCE 614 Aberdeen Way, Southlake, Texas 76092, USA		CITIZENSHIP USA
POST OFFICE ADDRESS same as above		

FULL NAME OF FIRST INVENTOR Mark S. Hansen	INVENTOR'S SIGNATURE	DATE
RESIDENCE 2280 Campbell Creek Blvd., Richardson, TX 75082, USA	CITIZENSHIP USA	
POST OFFICE ADDRESS same as above		